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Agricultural Liming Materials

Maryland Farmers bought over $800,000 worth of soil liming materials in 1923. The protection of lime buyers in the expenditure of this tremendous sum is of great importance. It also protects the honest manufacturer, preventing unfair competition.

This bulletin is published in order that lime buyers may have accurate information regarding limes bought from November 1, 1923, to November 1, 1924.

STATE LIME DEPARTMENT
Controlled by
UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

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AGRICULTURAL LIMING MATERIALS

November 1, 1923—November 1, 1924.

Compiled and edited under the supervision and direction of N. E. Gordon, State Chemist, and L. E. Bopst, in Charge of Lime, Feed and Fertilizer Departments.

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The inspection, analysis and control work of the lime fertilizer and feed trade is carried on by the State Department, but the State Department is so related to the chemical work of the University that the other men of the Chemical Staff who are mentioned below may be called on for help in time of need; and furthermore, it is the purpose of the majority of this Chemical Staff to be carrying on some investigations which bear directly or indirectly on the properties of fertilizers, feeds and limes.

CHEMICAL STAFF.

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INTRODUCTION

The Lime Inspection work performed during the spring and fall seasons of 1924, and conducted in accordance with the the Law regulating the sale of agricultural lime, consisted in the registration of brands offered for sale, the collection and analysis of official samples to determine whether or not the guarantys required to be printed upon sacks, or attached cards were correct, and the analyses of samples for residents of the State.

The Inspection is for the purpose of protecting the interests of the users of lime. The Maryland Lime Law requires that a statement of the guaranteed analysis be attached to the goods. The Inspection Service checks the manufacturer's statement of the analysis, and our reports show how the composition of the goods compares with that statement.

The Law also protects the manufacturer, because the statement of guaranteed analysis which must accompany all lime sold in this State protects the sellers of high grade goods from the competition of inferior products.

Our reports this year show but few failures on the part of manufacturers to live up to their guarantys.

THE MANUFACTURE AND EFFECTIVENESS OF SOIL LIMING MATERIALS

It has occurred to the Officials of the State Lime Department that the readers of the lime bulletins might find a brief account of the processes by which soil liming materials reach the Maryland market interesting, and to a certain extent helpful, as tending to create a better understanding of the different soil liming materials and the processes responsible for their presence. In the performance of their duties, the Representatives of the Lime Department have an opportunity to make a fairly thorough survey of this industry.

The following account is based on observation, in addition to available literature and should be considered not as a description of any one individual plant, but as a description of up-to-date methods and equipment as well as up-to-date ideas on the various subjects.

VARIETIES OF SOIL LIMING MATERIALS

In Maryland there are five soil liming materials commonly found on the market. They are quick or caustic lime in ground or lump form, hydrated lime, ground or crushed limestone, ground or crushed oyster shell and marl.

QUICK LIME

Process of Manufacture

Quick lime is obtained by heating limestone to its dissociation temperature under which condition the carbon dioxide and other volatile matter are expelled. Quick lime consists

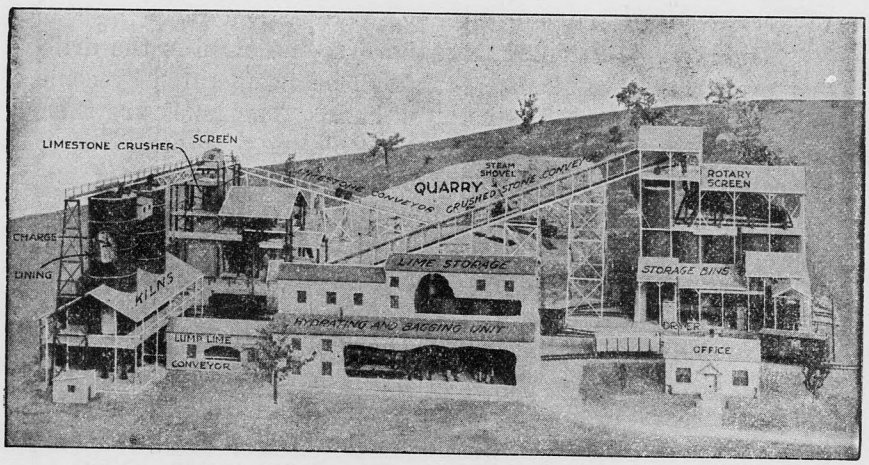

Fig. 1—A Modern Lime Plant, Arranged to Show the Sequence of Operations and the Process of Manufacture.

primarily of calcium oxide and magnesium oxide, but may contain small amounts of iron oxide and silica, with traces of other impurities, depending upon the purity of the stone from which the lime is made. For agricultural uses only the calcium oxide and the magnesium oxide are of value. The suitability of lime for agricultural purposes may therefore be controlled by the selection of the stone to be burned and by the thoroughness of the burning.

The manufacturing operations as given under the various sub-heads herein may be followed in their sequence by referring to the accompanying cut (Fig. 1), and these operations

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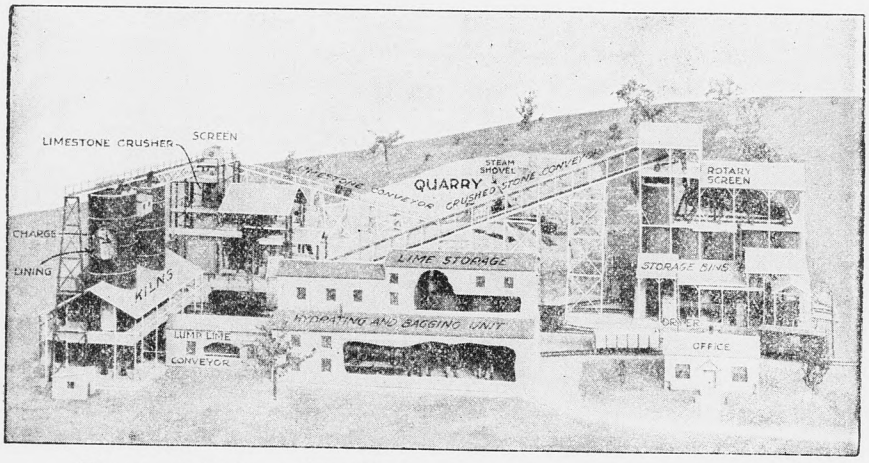

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The manufacturing operations as given under the various sub-heads herein may be followed in their sequence by referring to the accompanying cut (Fig. 1), and these operations

are also shown in their proper sequence by the graph (Fig. 2) appearing on the next page.

Locating the Quarry—The quarry must be located where geologic investigations indicate that there is a large supply of limestone very high in calcium carbonate or in the combined carbonates of calcium and magnesium, and very low in other constituents. It must also conform to certain physical requirements, such as transportation facilities, fuel supply, overburden and topography.

Stripping—Before opening the quarry the overburden must be removed. Depending upon local conditions, this stripping must be done by hand-digging, plow and shovel, steam shovels or hydraulically.

Quarrying—In quarrying, the first operation is the drilling preparatory to blasting, the drill being operated by compressed air, electricity, steam, or hand. The holes are then charged with powder and the stone blasted. In some cases, shooting before blasting is practiced, which consists of enlarging the drill hole with a miniature blast. Large boulders resulting from the blast are reduced to suitable sizes for the crushers by drilling and blasting or by hand-sledging.

Crushing—After sorting out the unsuitable material, the stone is delivered to the jaw-crushers by cable cars, belt conveyors, horse cars, or by gravity. The crushers reduce the largest sized stones to sizes that can be burned economically and effectively in the kilns, the smaller sizes passing through unchanged. In many quarries the mechanical crushing is entirely replaced by hand-sledging, in which case the "spalls" or "chips" are discarded.

Screening—From the Crushers, the lime rock is elevated by conveyor to a rotary or bar screen, where material larger than five inches in diameter passes over the screen and is conveyed to the top of the vertical shaft kilns and dumped into the kiln reservoir. Depending on local conditions, it may be conveyed by wheelbarrow, horse and cart, cable car, or belt conveyor. The material smaller than five inches in diameter, which passes through the screen is disposed of in one of two ways. It may be conveyed to the limestone mill where it is crushed and pulverized with hammer or bar mills and marketed

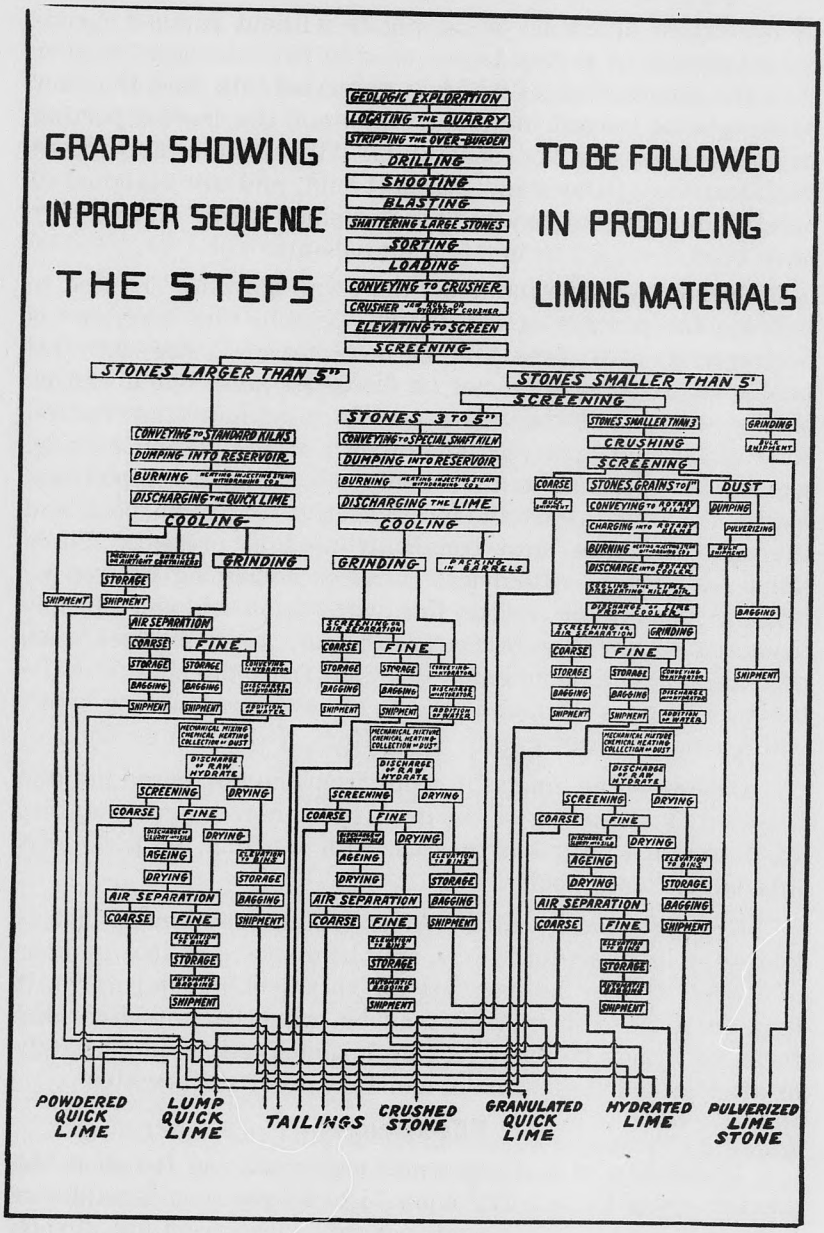
GRAPH SHOWING
IN PROPER SEQUENCE
THE STEPS
TO BE FOLLOWED
IN PRODUCING
LIMING MATERIALS
GEOLOGIC EXPLORATION
LOCATING THE QUARRY
STRIPPING THE OVER-BURDEN
DRILLING
SHOOTING
BLASTING
SHATTERING LARGE STONES
SORTING
LOADING
CONVEYING TO CRUSHER
CRUSHER
ELEVATING TO SCREEN
SCREENING
STONES LARGER THAN 5"
STONES SMALLER THAN 5"
STONES 3 TO 5"
STONES SMALLER THAN 3"
CONVEYING TO STANDARD KILNS
DUMPING INTO RESERVOIR
BURNING
DISCHARGING THE QUICK LIME
COOLING
GRINDING
STORAGE
SHIPMENT
AIR SEPARATION
COARSE
FINE
BAGGING
MECHANICAL MIXING CHEMICAL HEATING COLLECTION OF DUST
DISCHARGE AS RAW HYDRATE
SCREENING
DRYING
AGEING
CONVEYING TO SPECIAL SHAFT KILN
DISCHARGING THE LIME
CRUSHING
CONVEYING TO ROTARY KILNS
CHARGING INTO ROTARY KILNS
DISCHARGE INTO ROTARY COOLER
DISCHARGE FROM COOLER
DUST
DUMPING
PULVERIZING
BULK SHIPMENT
POWDERED QUICK LIME
LUMP QUICK LIME
TAILINGS
CRUSHED STONE
GRANULATED QUICK LIME
HYDRATED LIME
PULVERIZED LIME STONE

Figure 2.

as pulverized limestone or aggregate without further chemical treatment, or it may be screened to two finenesses smaller than five inches, each of which is converted into lime, the finer portion being burned in a rotary kiln and the coarser portion in a specially modified shaft kiln. These kilns are recent modifications of the standard shaft kiln, and are designed to handle the material too fine for the shaft kiln. As yet they have been installed in but few lime plants.

Burning—In the industry, the term "burning" is used to indicate the process of calcination whereby the limestone is decomposed into lime and carbon dioxide. The chemical principles involved need not be discussed here, but it can be briefly stated that there is a certain minimum temperature, time of heating, and partial pressure of the carbon dioxide, which are required to thoroughly effect the decomposition. Vertical shaft kilns are the most effective for the purpose, and they are the type most commonly used at present. These kilns are upright cylindrical furnaces consisting of iron or brick shells of various sizes, lined with fire brick, and suitably insulated. They may be fired with coal, wood, producer gas, or fuel oil. The flame enters the kiln from the side near the bottom and rises through the mass of downward moving stone, which stone is drawn from the bottom of the kiln as lime.

Cooling—The lime as it drops from the kiln is red hot and is cooled by spreading on the floor, by storage in a cooling bin, or, in case a rotary kiln was used for burning, by passing it through a rotary cooler.

Grinding and Packing—After cooling, the lime, which is known as lump or quick lime, may be disposed of in a number of ways. It may be barreled for shipment in lump form, it may be shipped in bulk, it may be converted into hydrated form, or it may be pulverized and bagged, either immediately or after an indefinite time in moisture proof storage bins.

Effectiveness

Quick lime is a concentrated material. As found on the market, quick limes carry from 75 to 95 per cent of oxides of lime, or 1,500 to 1,900 pounds per ton, with exceptions at each extreme.

Lump quick lime must be slaked before spreading on the soil. In this process, when employed on the farm, there is some loss in strength on account of incomplete action which leaves some lumps not finely divided. It has been estimated that the discount to offset this loss is about 10 to 15 per cent. In view of this most lump limes would have an effective strength of 1,400 to 1,700 pounds per ton.

When lump quick lime is ground the material retains a similar chemical composition but may be more widely distributed throughout the soil. Unlike the lump lime, the ground quick lime need not be slaked preparatory to spreading on the field, and hence its strength need not be discounted but will retain an effectiveness of 1,500 to 1,900 pounds of oxides of lime to the ton, depending upon the purity of the stone from which the lime was made and the thoroughness of the manufacturing process. Physically, the ground material resembles coarse meal in appearance; particles of fresh granular quick lime are roughly the size of grains of rye. In the soil, all quick limes take on water and are thus converted into slaked lime, after which the lime constituents function as though applied as slaked or hydrated lime.

HYDRATED LIME

Process of Manufacture

Hydrated lime is quick lime chemically satisfied with water and subjected to an extreme fineness of division. All of the operations to be gone through in the manufacture of quick lime are therefore necessary before hydrated lime can be obtained. The quick lime is converted into the hydroxide and disposed of as hydrated lime. In some plants all of a given batch of quick lime is hydrated, and in other plants only the finer portions, which are removed from the granulated material by air separation.

Hydration—The lump quick lime to be hydrated is crushed and conveyed mechanically to an apparatus that provides for supplying the lime with the proper amount of water at the proper rate to convert it into an hydroxide of the required chemical and physical properties. Three types of hydrators are in use, differing in principle, but all providing for mechani-

cal mixing and for conserving the heat of the chemical reaction in sufficient degree to hydrate effectively without burning. The hydrate may be discharged in a dry condition and bagged for shipment or it may be submitted to further chemical and mechanical treatment.

Ageing—Sometimes it is necessary to age the hydrate to effect complete hydration, in which case the wet material from the hydrator drops into a bin or silo where it is seasoned with moisture and heat for a time sufficient for hydration to be thoroughly completed.

Screening—The material from the hydrator, or from the silo in case the hydrate was aged, passes over a screen where that part which will not hydrate, consisting of carbonate, silicate, and other material in lump form, is removed.

Finishing—The hydrated lime is finished for the market by reducing it to a very fine pulverulent condition. It is done by a combined milling and air-separation process, or by passing it through some standard pulverizing mill, such as a tube mill or a roller mill.

Storage and Bagging—The material is next elevated to bins from which it passes into automatic bagging machines, where it is prepared for shipment in paper or cloth bags.

Effectiveness

The oxides of lime equivalents in hydrated limes run from 60 to 80 per cent; that is, 1,200 to 1,600 pounds of oxides of lime to the ton. Being a product of burnt lime, this hydrate is quite active in the soil. It may speedily combine with silicate substances in a useful capacity or change into the carbonate form again, in which case it is thoroughly available by virtue of its fine state of division either for the plant or improving the general productivity of the soil.

Physically, hydrated lime is ideal; it is a flour-like powder. The great part of most hydrate is finer than 1/200 of an inch, or will pass a 200 mesh sieve. The active chemical form and the extreme fineness of this material contribute to its fullest efficiency in the soil.

GROUND OR CRUSHED LIMESTONE

Process of Manufacture

As the name implies, this product is made by grinding the raw limestone rock. The sequence of the operations necessary to produce this product are identical with the first steps required in getting the stone ready for the lime kiln, as previously described. In other words, the quarry must be located, the overburden must be stripped, the quarrying (drilling and blasting) must be done, the stone must be crushed, screened into sizes suitable for the mill, then ground until it is in a pulverized condition, fine enough to be bagged and placed on the market. The sequence of these steps, as stated above, is given under the heading of the process of manufacture for quick lime, and is also shown under Fig. 2.

Effectiveness

The oxides of lime equivalents in this material range from 45 to 55 per cent., depending upon the purity of the original stone, or from 900 to 1,100 pounde of oxides to the ton. The total number of pounds of oxides in a ton of ground limestone, as commonly found on the market in this State, however, do not conform to the total number of pounds of available or effective oxides in the material, but must be discounted according to the mechanical analysis. The amount of such discount has been the basis of a good many investigations in various states. Different findings on this point have been reported by various investigators, and the concensus of opinion seems to indicate that it is only that portion of the material which will pass through an 80-mesh sieve that is immediately available to soils and crops, although it is found that practically all of the material passing through a 60-mesh sieve is theoretically available in the course of years. A very satisfactory method that has been advanced for discounting the effectiveness of ground limestone is to ascribe, over a five-year period, full availability to that which passes a 60-mesh sieve, one-half availability to that which is caught on the 60-mesh sieve but passes a 20-mesh sieve, and to consider as practically inactive that material which is caught on a 20-mesh sieve. When figured on this scale, and taking into

consideration the actual oxide of lime content, the effective oxides of lime in the average ton of limestone found on the Maryland market will range from 800 to 1,050 pounds.

The effectiveness, then, of ground limestone is governed almost entirely by the fineness of grinding, and for this reason the mechanical analyses is primarily the limiting factor. Particular attention is therefore paid to this factor as a measure of protective service, as we pick up samples of limestone with a wide range of variance in mechanical analyses; in some of these samples over half of the material will readily pass through an 80-mesh sieve, indicating an excellent availability, and in other samples we have found that over half of it is caught on a 20-mesh sieve, indicating a very dilute material, which must be applied in excessive quantity in order to place any appreciable amount of its effective portion in the soil.

GROUND OR CRUSHED OYSTERS SHELLS

Process of Manufacture

As is the case in the producing of agricultural limestone, the manufacture of pulverized oyster shells for soil-liming is comparatively a simple process. The industry, of course, has its geographical limitation, inasmuch as a continuous supply of shells must be assured before justification can be had for the installation of grinding, bagging and shipping apparatus.

More than one type of mill is in use for grinding this material, but the sole object is always to pulverize, and no description need be given of any particular crusher or grinder.

Realizing the economy of being able to place a concentrated form of soil-liming material on the market, attempts have been made by several concerns in Maryland to bake or burn the shells on a commercial scale, so as to dissociate them sufficiently to drive off, at least partially, the carbon dioxide. The samples we have obtained of the material, however, have shown only slightly higher oxide content than in the ordinary ground, raw shells, indicating that the method used is for some reason ineffective, except as a material aid in the grinding of the sample.

Effectiveness

The oxides of lime equivalents in oyster shells will range from 35 to 50 per cent., depending upon the amount of sand and insoluble matter present. This means 700 to 1,000 pounds of oxides to the ton. Here again, distinction must be made between the total oxides and the effective oxides, as the total must be discounted in proportion to the fineness of the material. The formula that has been recommended for the calculation of available oxides in ground limestone is also applicable to oyster shells, which will show an effective oxide of lime content of somewhere between 500 and 800 pounds to the ton, with some exceptions at one extreme and some exceptions at the other. Attention is therefore directed to the mechanical analyses of the material rather than the chemical analyses, as shells are fairly constant in their composition, but may and do vary widely in degree of fineness when ground and placed on the market as a soil-liming material. When material, ground fine enough to pass a 100-mesh sieve, is applied at the rate of 2,000 pounds per acre, it will have a theoretical possible distribution in the soil of about 1,100 particles to the cubic inch, whereas material that is just fine enough to pass a 20-mesh sieve will have, when applied at the same rate, a a possible distribution of less than 20 particles to the cubic inch.

MARL

As described here, marl is the precipitated carbonate as found in Western Maryland and adjacent states.

Process of Manufacture

Thus far no methods have been generally adopted for driving off the carbon dioxide from marl, in order to place it upon the market in a more concentrated form. The main object of the producers of this material has been not to heat the marl to its dissociation temperature but to heat sufficiently so that it will dry out enough to be ground and run through a lime spreader. The methods employed have been in some instances fairly efficient.

Some marl handlers allow their products to air-dry under cover for several weeks; thereby, considerably reducing the moisture content, and next to transfer it to cribs under which there is a heated pipe, in this manner a further reduction in moisture is made.

Rotary driers, somewhat similar to those found in lime kilns, have also been used by marl handlers as a means of eliminating excess moisture. Still another process has been to load the marl on a steel car and to run this car over a heating device, and allow it to stand until moisture in the material has been somewhat reduced.

While the above are not all the methods employed by various marl handlers they tend to give the reader a general idea of the process employed.

Effectiveness

The total oxides of lime in marl will run from 45 to 55 per cent. or 900 to 1,100 pounds to the ton. However, as is the case with other soil-liming materials that depend upon fineness for efficiency, a certain discount must be made in order to arrive at the effective oxides to the ton, as there is very apt to be a wide margin of variance between different marls in this respect. We have had samples in the laboratory which according to mechanical analyses showed that more than 70 per cent. was caught on a 20-mesh sieve, and we have had other samples where 70 per cent. of the material passed through a 60-mesh sieve. The exact amount of discount to be taken into consideration when figuring on this kind of material is, therefore, rather hard to obtain, and it is desirable to rely upon the mechanical analyses or screening tests in each instance as well as the percentage of Calcium Oxide present, rather than to formulate any general conclusions as to the value of the various marls when taken as a group.

Unless is is thoroughly dried, the condition of marl is very likely to be lumpy, making uniform distribution in the soil somewhat difficult. The availability of the finer particles of the marl is good, but the coarser, lumpy particles have a tendency to become available very slowly.

IMPORTANCE OF MECHANICAL ANALYSES.

It must always be remembered that in order for a particle of soil-liming material to work on a particle of soil, there must be direct contact between the two. Therefore, the finer the liming material applied, the greater the number of particles there will be to come into contact with particles of the soil; and the coarser the particles of liming material applied, the less will be the number of contacts made between the two and therefore the less will be the number of soil particles affected, and the less will be the effeciency of the application.

TABLES

The tables on the following pages contain the results of the analysis of various forms of agricultural lime products for the year ending November, 1924.

ANALYSES OF AGRICULTURAL BURNT LIME (OXIDES)

No.	Name of Manufacturer or Agent	Name of Lime	Place of Sampling	Calcium Oxide CaO		Magnesium Oxide MgO		Sand & Insol. (no Val.)	Total Oxides Equivalents. CaO+MgO
				Found	Guaranteed	Found	Guaranteed	Found	
1474	J. E. Baker Company, York, Pa.	Victor Burned Lime	York, Pennsylvania	**95.82**	85.00	**1.45**	2.00	**.32**	**97.27**
1428	J. E. Baker Company, York, Pa.	Victor Burned Lime	York, Pennsylvania	**94.48**	85.00	**2.78**	2.00	**.35**	**97.26**
1516	S. W. Barrick and Sons, Woodsboro, Maryland	Agricultural Ground Lump Lime	Woodsboro	**63.58**	85.00	**7.75**	5.00	**7.85**	**71.33**
1514	S. W. Barrick and Sons, Woodsboro, Maryland	Lump Lime	Woodsboro	**89.15**	85.00	**1.67**	5.00	**.80**	**90.82**
1496	Blair Limestone Company, Pittsburgh, Pennsylvania	Shenandoah Ground Lime	Pittsburgh, Pa.	**49.14**	48.00	**32.40**	32.00	**6.08**	**81.54**
1425	Blair Limestone Company, Pittsburgh, Pennsylvania.	Shenandoah Ground Lime	Martinsburg, W. Va.	**49.83**	48.00	**32.87**	32.00	**4.64**	**82.70**
1532	Geo. Bushey and Son, Cavetown, Maryland.	Lump Lime	Cavetown	**84.67**	85.00	**2.17**	2.00	**1.44**	**86.84**
1498	Emig Lime Co., Hellam, Pa.	Agric. Lump Lime	Hellam, Pa.	**92.29**	86.00	**.86**		**.52**	**93.15**
1519	M. J. Groves Lime Company, Frederick, Maryland.	Ground Lime (Lump)	Frederick	**66.48**	75.00	**9.49**	5.00	**6.28**	**75.97**
1517	M. J. Groves Lime Company, Frederick, Maryland.	Lump Lime	Frederick	**92.06**	75.00	**4.02**	5.00	**.30**	**96.08**
1520	John S. Hyde, Westminster, Md.	Burnt Lump Lime	Westminster	**87.58**	85.00	**5.86**	5.00	**.84**	**93.44**
1478	Merion Lime and Stone Co., Norristown, Pennsylvania.	Run of Kiln Lime	Norristown, Pa.	**57.12**	50.00	**41.21**	30.00	**10.40**	**98.33**

.40

1454	Henry Mosser, Oakland, Md.	Burnt Lime	Oakland	**55.78**	42.00	**1.14**	.91	**19.04**	**56.92**
1485	Palmer Lime and Cement Co., York, Pennsylvania.	Lump Lime	York, Pennsylvania.	**92.51**	88.00	**1.59**	6.00	**.16**	**94.10**
1471	Powhatan Lime Company, Strasburg Junction, Va.	Lump Lime	Strasburg Junction, Virginia	**92.96**	65.00	**.91**	5.00	**.10**	**93.87**
1526	Shank and Etzler, Frederick, Md.	Lump Lime	Frederick	**58.58**	60.00	**37.14**	30.00	**.10**	**95.72**
1482	Steacy and Wilton Company, Wrightsville, Pa.	Run of Kiln Lump Agricultural Lime	Wrightsville, Pa.	**85.89**	80.00	**6.76**		**.44**	**92.65**
1490	Chas. Warner Company, Philadelphia, Pa.	Pulverized Burned Lime.	Philadelphia, Pa.	**55.21**	54.00	**36.20**	36.00	**3.20**	**91.41**
1491	Chas. Warner Company, Philadelphia, Pa.	Run of Kiln Lime	Philadelphia, Pa.	**55.94**	56.00	**39.17**	37.00	**1.16**	**94.11**
1470	Washington Building Lime Co., Baltimore, Maryland.	Ground Lime (in bags)	Baltimore	**90.27**	90.00	**2.17**		**1.20**	**92.44**

ANALYSES OF AGRICULTURAL HYDRATED LIME

No.	Name of Manufacturer or Agent	Name of Lime	Place of Sampling	Calcium Oxide CaO		Magnesium Oxide MgO		Sand & Insol. (No Val.)	Total Oxide Equivalent CaO+MgO
				Found	Guaranteed	Found	Guaranteed	Found	
1431	J. E. Baker Company, York, Pa.	Susquehanna Hydrated Lime	York, Pennsylvania	**65.80**	65.00	**5.95**	3.00	**.64**	**71.75**
1476	J. E. Baker Company, York, Pa.	Susquehanna Hyd. Lime	York, Pennsylvania	**71.24**	65.00	**2.65**	3.00	**.24**	**73.89**
1475	J. E. Baker Company, York, Pa.	Victor Agricultural Hydrated Lime	York, Pennsylvania	**59.36**	55.00	**14.35**	15.00	**.48**	**73.71**
1429	J. E. Baker Company, York, Pa.	Victor Agricultural Hydrated Lime	York, Pennsylvania	**53.87**	55.00	**22.57**	15.00	**2.04**	**76.44**
1500	S. W. Barrick and Sons, Woodsboro, Maryland	Agricultural Hydrated Lime	Colora	**57.27**	65.00	**4.34**	3.00	**7.40**	**61.61**
1515	S. W. Barrick and Sons, Woodsboro, Maryland	Agricultural Hydrated Lime	Woodsboro	**56.17**	65.00	**5.30**	3.00	**7.50**	**61.47**
1495	Blair Limestone Company, Pittsburgh, Pa.	Opequon Hydrated Lime	Pittsburgh, Pa.	**66.46**	65.00	**1.26**	2.00	**2.90**	**67.72**
1497	Blair Limestone Company, Pittsburgh, Pa.	Special Hydrated Lime	Pittsburgh, Pa.	**64.41**	60.00	**1.80**	1.50	**2.80**	**66.21**
1518	M. J. Grove Lime Company, Frederick, Maryland	Hydrated Lime	Frederick	**55.28**	65.00	**8.35**	5.00	**7.00**	**63.63**
1487	Knickerbocker Lime Company, Philadelphia, Pa.	Hydrated Lime	Philadelphia, Pa.	**51.13**	45.00	**31.17**	30.00	**.72**	**82.30**
1521	LeGore Combination Lime Co., LeGore, Maryland	Hydrated Lime	LeGore	**63.84**	67.00	**4.06**	3.00	**4.88**	**67.90**
1477	Merion Lime and Stone Co., Norristown, Pa.	Hydrated Lime	Norristown, Pa.	**44.08**	44.00	**31.02**	30.00	**1.92**	**75.11**

1484	Palmer Lime and Cement Co., York, Pennsylvania	Challenge Brand Hydrated Lime	York, Pennsylvania	70.67	65.00	2.61	5.00	.36	73.28
1523	Palmer Lime and Cement Co., York, Pennsylvania	Challenge Brand Hydrated Lime	Westminster	67.82	65.00	6.19	5.00	.20	74.01
1509	Security Cement and Lime Co., Hagerstown, Maryland	Berkeley Hydrated Lime	Hagerstown	71.23	70.00	1.55	2.00	.17	72.78
1525	Security Cement and Lime Co., Hagerstown, Maryland	Berkeley Hydrated Lime	Gaithersburg	70.06	70.00	1.59	2.00	.32	71.65
1527	Shank and Etzler, Frederick, Md.	Hydrated Lime	Frederick	40.43	45.00	25.16	20.00	6.12	65.59
1481	Steacy and Wilton Company, Wrightsville, Pa.	Sterling Brand Hydrated Lime	Wrightsville, Pa.	68.83	68.20	4.56		.56	73.39
1528	Steacy and Wilton Company, Wrightsville, Pa.	Sterling Brand Hydrated Lime	Westminster	67.57	68.20	4.19		2.04	71.76
1529	Tidewater Portland Cement Company, Baltimore, Md.	Hydrated Lime	Union Bridge	70.00	71.00	1.04	.50	1.32	71.04
1506	Charles Warner Company, Philadelphia, Pennsylvania	Limoid (Hydrated Lime)	Preston	47.15	45.00	32.44	30.00	1.92	79.59
1444	Charles Warner Company, Philadelphia, Pennsylvania	Limoid (Hydrated Lime)	Conowingo	46.48	45.00	30.41	30.00	2.15	76.89
1489	Charles Warner Company, Philadelphia, Pennsylvania	Limoid Inoculated	Philadelphia, Pa.	46.09	45.00	31.35	30.00	1.68	77.44
1468	Washington Building Lime Co., Baltimore, Maryland	Standard Hydrated Lime (in bags)	Baltimore	70.69	70.00	1.94	2.00	2.08	72.63
1530	Washington Building Lime Co., Baltimore, Maryland	Standard Hydrated Lime	Gaithersburg	68.30	70.00	1.74	2.00	2.28	70.04

ANALYSES OF AGRICULTURAL LIMESTONE, MARL AND OYSTER SHELLS

No.	Name of Manufacturer or Agent	Name of Lime	Place of Sampling	Calcium Oxide CaO		Magnesium Oxide MgO		Sand & Insol (No Val.)	Tatal Ozide Equivalents CaO+MgO
				Found	Guaranteed	Found	Guaranteed	Found	
1472	Alba Marl Lime Company, Charlestown, W. Va.	*Alba Marl	Charles Town, W. Va.	**52.64**	50.00	**.20**	.50	**1.40**	**52.84**
1499	J. E. Baker Company, York, Pa.	*Victor Fine Ground Limestone	Greensboro	**46.76**	47.00	**6.15**	2.00	**3.48**	**52.91**
1473	J. E. Baker Company, York, Pa.	*Victor Fine Ground Limestone	York, Pennsylvania	**46.60**	47.00	**5.52**	2.00	**2.36**	**52.12**
1430	J. E. Baker Company, York, Pa.	Victor Fine Ground Limestone	York, Pennsylvania	**48.38**	47.00	**5.30**	2.00	**2.76**	**53.68**
1501	Herbert Bryant's Son, Alexandria, Virginia	*Ground Oyster Shell Lime	Crisfield	**48.83**	45.00	**.41**		**7.20**	**49.24**
1439	Herbert Bryant's Son, Alexandria, Virginia	*Ground Oyster Shell Lime	Crisfield	**48.22**	45.00	**.47**		**9.30**	**48.69**
1502	Dorchester Fertilizer and Lime Cambridge, Maryland	*Ground Oyster Shell Lime	Cambridge	**41.44**	40.00	**.37**		**18.16**	**41.81**
1440	Dorchester Fertilizer and Lime Co. Company, Cambridge, Md.	*Ground Oyster Shell Lime	Cambridge	**48.54**	40.00	**.62**		**13.50**	**49.16**
1448	East Coast Trading Company, Baltimore, Maryland	*Ground Oyster Shell Lime	Baltimore	**47.04**	47.00	**.54**	.50	**15.10**	**47.58**
1456	East Coast Trading Company, Baltimore, Maryland	*Ground Oyster Shell Lime	Baltimore	**46.93**	47.00	**.58**	.50	**11.84**	**47.51**
1488	Knickerbocker Lime Company, Philadelphia, Pennsylvania	*Pulverized Limestone	Philadelphia, Pa.	**30.19**	26.00	**20.85**	18.00	**2.64**	**51.04**
1522	LeGore Combination Lime Co., LeGore, Maryland	*Ground Limestone	LeGore	**45.70**	50.00	**4.27**	2.00	**14.00**	**49.97**

1449	Henry Mosser, Oakland, Md.	Granulated Lime	Oakland	48.66	42.00	.91	.91	8.71	49.57
1503	Natural Lime Marl Company, Roanoke, Virginia	*Lime Marl	Colora	48.16	50.00	.47	.50	3.52	48.63
1467	Natural Lime Marl Company, Roanoke, Virginia	*Lime Marl	Roanoke, Virginia	50.50	50.00	.36	.50	5.04	50.86
1504	Palmer Lime and Cement Co., York, Pennsylvania	*Ground Limestone	Colora	48.16	48.00	5.45	6.00	1.20	53.61
1483	Palmer Lime and Cement Co., York, Pennsylvania	*Ground Limestone	York, Pennsylvania	53.90	48.00	1.73	6.00	.32	55.63
1531	Geo. H. Poffenberger, Sharpsburg, Maryland	Agricultural Limestone	Sharpsburg	49.90	50.00	.50		3.72	50.40
1524	Potomac Poultry Food Co., Inc., Baltimore, Maryland	*Ground Oyster Shell Lime	Gaithersburg	40.99	47.00	.36	.50	20.00	41.35
1505	Potomac Poultry Food Co., Inc., Baltimore, Maryland	*Ground Oyster Shell Lime	Crisfield	44.32	47.00	.43	.50	14.64	44.75
1457	Potomac Poultry Food Co., Inc., Baltimore, Maryland	*Ground Oyster Shell Lime	Baltimore	38.70	47.00	.69	.50	19.58	39.39
1441	Potomac Poultry Food Co., Inc., Baltimore, Maryland	*Ground Oyster Shell Lime	Crisfield	49.28	47.00	.58	.50	9.00	49.86
1510	Security Cement and Lime Co., Hagerstown, Maryland	*Berkeley Pulverized Limestone	Hagerstown	40.32	44.00	8.16		8.36	48.48
1534	Standard Lime and Stone Co., Baltimore, Maryland	*Pulverized Limestone	Elkridge	53.76	50.43	.58	.50	1.76	54.34
1494	W. H. Valliant and Bro., Bellevue, Maryland	Baked and Ground Lime	Bellevue	47.15	45.00	.30		9.28	47.45
1442	W. H. Valliant and Bro., Bellevue, Maryland	Baked and Ground Lime	Bellevue	45.53	45.00	.65		10.80	46.18
1443	W. H. Valliant and Bro., Bellevue, Maryland	Burnt and Ground Lime	Bellevue	48.22	45.00	.84		10.35	49.06
1493	W. H. Valliant and Bro., Bellevue, Maryland	Burnt and Ground Lime	Bellevue	45.36	45.00	.60		10.08	45.96
1492	Charles Warner Company, Philadelphia, Pennsylvania	*Pulverized Limestone	Philadelphia, Pa.	30.46	29.00	21.18	19.00	2.16	51.64

*Ground Shells or Stone, Mechanical Analysis on Pages 23 and 24.

ANALYSIS OF GYPSUM OR LAND PLASTER

No.	Name of Manufacturer or Agent	Name of Lime	Place of Sampling	$CaSO_4$		Sand & Insol. (No Val.)
				Found	Guaranteed	Found
1446	American Agri. Chemical Co., Baltimore, Maryland	Ground Land Plaster	Upper Marlboro	**74.48**	74.00	**2.84**
1438	American Agri. Chemical Co., Baltimore, Maryland	Ground Land Plaster	Baltimore	**69.80**	74.00	**4.15**
1435	American Agri. Chemical Co., Baltimore, Maryland	Ground Land Plaster	Baltimore	**67.32**	74.00	**2.88**
1458	G. Ober and Sons Co., Baltimore, Maryland	Nova Scotia Land Plaster	Baltimore	**74.85**	77.70	**4.70**
1436	G. Ober and Sons Co., Baltimore, Maryland	Nova Scotia Land Plaster	Baltimore	**75.36**	77.70	**2.60**
1513	United States Gypsum Co., Chicago, Illinois	Ben. Franklin Agric. Gypsum (Land Plaster)	Chicago, Illinois	**67.18**	68.02	**9.70**

ANALYSIS OF MISCELLANEOUS PRODUCTS

No.	Name of Manufacturer or Agent	Name of Lime	Place of Sampling	Calcium Oxide CaO		Magnesium MgO		Sand & Insol. (No Val.)	Total Oxides Equivalents CaO+MgO
				Found	Guaranteed	Found	Guaranteed	Found	
1508	Security Cement and Lime Co., Hagerstown, Maryland	Berkeley Hydra-Calcite Lime	Hagerstown	**66.08**	20.00	**2.28**	2.00	**1.00**	**68.36**
1469	Washington Building Lime Co., Baltimore, Maryland	Standard Two-in-One (Lime and Limestone)	Baltimore	**54.00**	35.00	**2.29**	1.00	**1.80**	**56.29**

TABLE II—SHOWING MECHANICAL ANALYSIS OF GROUND LIMESTONE AND GROUND OYSTER SHELL

For the Chemical Analyses of these samples, see preceding table. Figures are percentages or pounds per hundred. "Mesh" indicates the sieve used; "20 Mesh" has 20 wires to the inch.

No.	Name of Manufacturer or Agent	Name of Lime or Kind	Finer than 100 Mesh	Bet. 80 and 100 Mesh	Bet. 60 and 80 Mesh	Bet. 40 and 60 Mesh	Bet. 20 and 40 Mesh	Coarser than 20 Mesh
1472	Alba Marl Lime Company, Charlestown, W. Va.	Alba Marl	11	22	2	7	19	39
1499	J. E. Baker Company, York, Pa.	Victor Fine Ground Limestone	73	4	1	7	12	3
1473	J. E. Baker Company, York, Pa.	Victor Fine Ground Limestone	97	3	0	0	0	0
1501	Herbert Bryant's Son, Alexandria, Virginia	Ground Oyster Shell Lime	33	19	4	14	29	1
1439	Herbert Bryant's Son, Alexandria, Virginia	Ground Oyster Shell Lime	23	16	1	18	40	2
1502	Dorchester Fert. and Lime Co., Cambridge, Maryland	Ground Oyster Shell Lime	38	11	4	15	28	4
1440	Dorchester Fert. and Lime Co., Cambridge, Maryland	Ground Oyster Shell Lime	15	15	4	20	43	3
1448	East Coast Trading Company, Baltimore, Maryland	Ground Oyster Shell Lime	17	17	5	21	37	3
1456	East Coast Trading Company, Baltimore, Maryland	Ground Oyster Shell Lime	33	14	3	14	35	1
1488	Knickerbocker Lime Company, Philadelphia, Pennsylvania	Pulverized Limestone	94	3	1	2	0	0
1522	LeGore Combination Lime Co., LeGore, Maryland	Ground Limestone	94	3	1	2	0	0

TABLE II—SHOWING MECHANICAL ANALYSIS OF GROUND LIMESTONE AND GROUND OYSTER SHELLS. (Con.)

No.	Name of Manufacturer or Agent	Name of Lime or Kind	Finer than 100 Mesh	Bet. 80 and 100 Mesh	Bet. 60 and 80 Mesh	Bet. 40 and 60 Mesh	Bet. 20 and 40 Mesh	Coarser than 20 Mesh
1503	Natural Lime Marl Company, Roanoke, Virginia	Lime Marl	8	26	33	8	16	9
1467	Natural Lime Marl Company, Roanoke, Virginia	Lime Marl	40	8	4	8	20	20
1504	Palmer Lime and Cement Co., York, Pennsylvania	Ground Limestone	100	0	0	0	0	0
1483	Palmer Lime and Cement Co., York, Pennsylvania	Ground Limestone	64	0	13	4	9	10
1524	Potomac Poultry Food Co., Inc. Baltimore, Maryland	Ground Oyster Shell Lime	38	10	6	20	25	1
1505	Potomac Poultry Food Co., Inc. Baltimore, Maryland	Ground Oyster Shell Lime	31	21	7	15	25	1
1457	Potomac Poultry Food Co., Inc.	Ground Oyster Shell Lime	28	16	10	17	27	2
1441	Potomac Poultry Food Co., Inc. Baltimore, Maryland	Ground Oyster Shell Lime	24	16	2	19	39	0
1510	Security Cement and Lime Co., Hagerstown, Maryland	Berkeley Pulverized Limestone	98	2	0	0	0	0
1534	Standard Lime and Stone Co., Baltimore, Maryland	Pulverized Limestone	53	13	3	16	15	0
1492	Chas. Warner Co., Phila., Pa.	Pulverized Limestone	94	3	1	2	0	0